ADDENDUM TO THE MEMORANDUM OF UNDERSTANDING

T945-A2

Muon Veto and Shielding Upgrade For COUPP 2-liter chamber test In the MINOS Hall

July 6, 2008

INTRODUCTION

This Addendum to the T945 Memorandum of Understanding describes upgrades to the COUPP 1-liter bubble chamber and its infrastructure that are planned for the summer of 2008. The largest element in this upgrade is a liquid scintillator based muon veto which will replace both the solid polyethylene neutron shielding and the scintillator paddle based muon veto that are currently in use. Other elements of the upgrade include the installation of a new synthetic silica 2-liter inner vessel, the installation of a new hydraulic controller, and the installation of upgraded data acquisition hardware and software.

This is a memorandum of understanding between FNAL and the experimenters in COUPP. This memorandum is intended solely for the purpose of providing a work allocation for FNAL and the experimenters. It reflects an arrangement that is currently satisfactory to the parties involved. It is recognized, however, that changing circumstances of the evolving research program may necessitate revisions. The parties agree to negotiate amendments to this memorandum to reflect such revisions.

The goal of the COUPP collaboration is to search for dark matter interactions using a specialized CF_3I bubble chamber technology that is sensitive to nuclear recoils but insensitive to other types of radiation. The collaboration is currently in the construction and commissioning phase for a 60 kg CF_3I device (E-961) and expects to continue with the development of a 1-ton scale experiment.

The COUPP 1-liter chamber has served as a useful R&D platform for obtaining engineering and physics information that informs the development of our larger chambers. It has also produced new physics limits on spin-dependent WIMP interactions. The COUPP 1-liter chamber operates under the T945 test beam designation and has been running in the MINOS near hall onsite at Fermilab since 2005. The technical issues currently under investigation are radon emanation from inner detector components, alpha particle emissions from the walls of the quartz bubble chamber vessel, and neutron backgrounds induced by cosmic radiation.

Radon induced events are believed to be the current limitation to the physics reach of the experiment. Alpha emissions from the vessel are not a background for the experiment, but they are a source of dead-time. These events limit the size of a chamber that can be operated and limit the ability of a chamber to use short time correlations to identify radon decay chain events. Cosmic induced neutron events are not expected to be a major source of background in a deep underground site, but they do need to be well understood and in the MINOS area these events limit our ability to measure the other important backgrounds.

The new synthetic silica vessel will address the alpha emission issue. The improved muon veto and shielding system will allow continued R&D progress in the MINOS area before moving all operations to a deeper site. The improvements to hydraulics, controls, and data acquisition are all incremental improvements along the path to a larger and more refined experiment. Together, these improvements will allow continued progress on the crucial issue which is the development of specialized materials and of specialized handling and cleaning procedures to eliminate the radon contamination. The revised muon veto system is shown in figure 1.

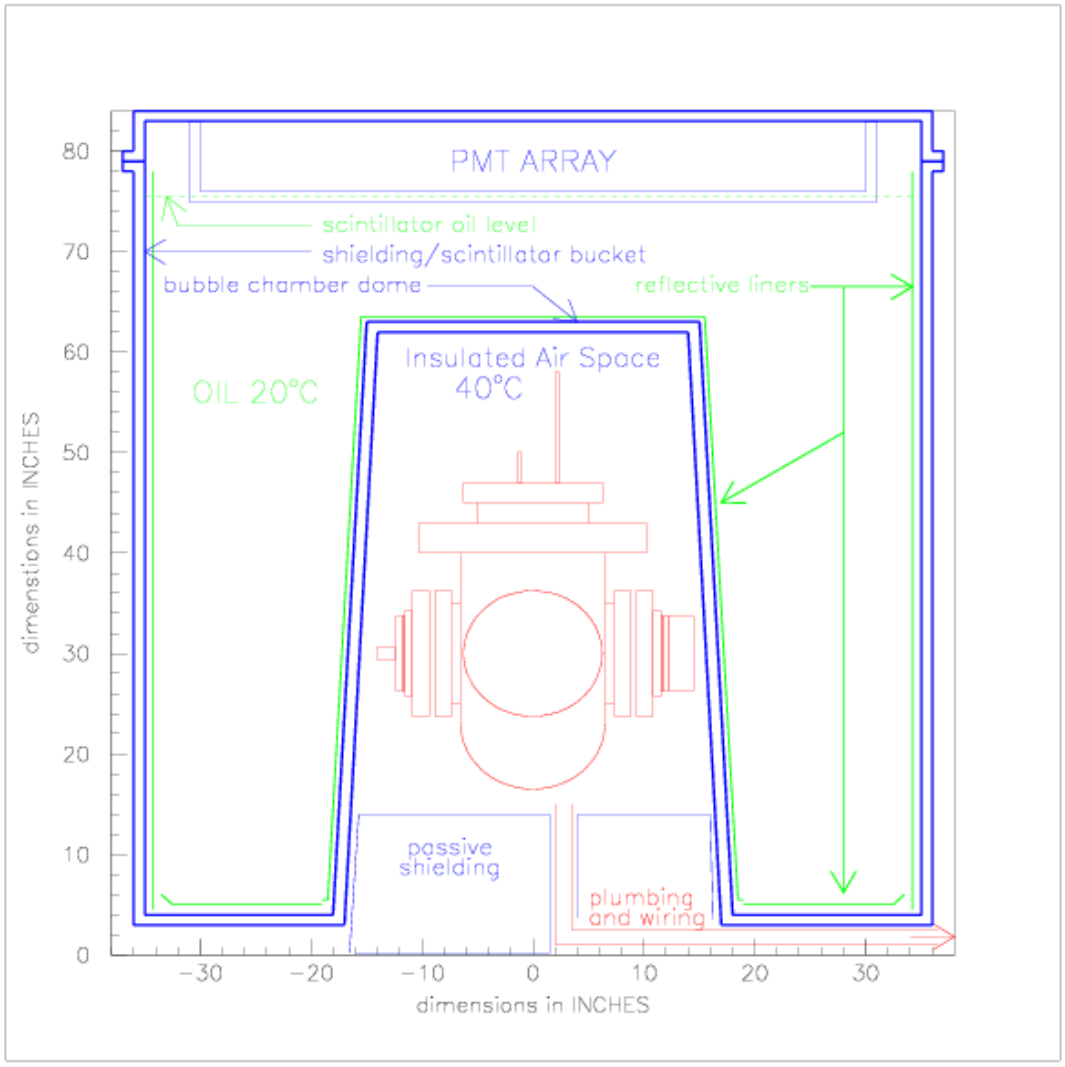

Figure 1: Schematic illustration of the new liquid scintillator veto / shielding sytem. The inner dome structure provides a pneumatic caisson to separate the bubble chamber from the liquid scintillator which is contained in a commercial 1500 gallon cylindrical tank. The scintillator is viewed by a photomultiplier tube array suspended from above.

I. PERSONNEL AND INSTITUTIONS:

Spokesman and physicist in charge of COUPP 1-liter upgrade: Mike Crisler

1.1 Kavli Institute for Cosmological Physics University of Chicago: Juan Collar(PI, COUPP Spokesperson), Luke Goetzke, Brian Odom, Nathan Riley, Hannes Schimmelpfennig, Matthew Szydagis.

1.2 Department of Physics, Indiana University South Bend: Ed Behnke, Ilan Levine(PI), Tina Marie Shepherd

1.3 Fermi National Accelerator Laboratory: Stephen Brice, Peter Cooper, Michael Crisler, Lauren Hsu, Martin Hu, Erik Ramberg, Andrew Sonnenschein, Robert Tschirhart

II. EXPERIMENTAL AREA, BEAMS AND SCHEDULE CONSIDERATIONS

2.1 LOCATION

2.1.1 The photomultiplier array and its supports will be built and tested at lab 8 and then lowered into the MINOS near hall. The bubble chamber rework will be done in PAB.

2.2 BEAM

This effort does not require the use of Fermilab particle beams.

2.3 SETUP

The setup will be in the MINOS Near Detector Hall in the same location currently used by the COUPP experiment.

2.4 SCHEDULE

It is expected that the upgrade work will be completed in July and August of 2008 and that the new equipment could be installed in the MINOS area in August 2008.

III. RESPONSIBILITIES BY INSTITUTION - NON FERMILAB

3.1 The University of Indiana South Bend will provide improved acoustic sensors along with technical support necessary for their installation on the chamber.

IV. RESPONSIBILITIES BY INSTITUTION - FERMILAB

4.1 **Fermilab Accelerator Division:**

4.1.1 Use of the AD cleaning facilities in A0 for cleaning of the new inner vessel, the bellows and flange assembly, and the inner plumbing parts.

4.1.S Summary of Beam Division costs:

Type of Funds	Equipment	Operating	Personnel (person-weeks)
Total new items	$0.0K	$0K	1.0

4.2 **Fermilab Particle Physics Division:**

All material purchases will be paid for with E-961 funds already allocated.

4.2.1 The PPD Technical Centers Department will take responsibility for the design and construction of the PMT array and supports. The system will use photomultiplier tubes currently in surplus in Lab 6. (4 person weeks) [$2K]

4.2.2 The PPD Technical Centers Department will take responsibility for commissioning and firmware revisions to the hydraulic carts. (1 person week) [$0K]

4.2.3 The PPD Mechanical Department will take responsibility for moving the COUPP equipment out of the MINOS area for rework and back into the MINOS area for the new installation. (1 person week)

4.2.4 The PPD Mechanical Department will take responsibility for the engineering and design of the liquid scintillator vessel, inner dome, and for the plumbing and handling issues associate with the liquid scintillator. (4 person weeks) [$8K]

4.2.5 The PPD Mechanical Department will take responsibility for technical support associated with improving the plumbing connections and instrumentation wiring. (2 person weeks)[$1K]

4.2.6 Surplus liquid scintillator (NuTEV) and reject NOVA mineral oil will be used.

4.2.7 Data Acquisition Upgrade will be accomplished using equipment in hand and programming efforts by PPD collaborators.

4.2.S Summary of Particle Physics Division costs:

Type of Funds	Equipment	Operating	Personnel (person-weeks)
Total new items	$11.0K	$0K	11

4.3 Fermilab Computing Division

4.3.1 No support from the computing division is needed for the muon veto addition.

4.4 Fermilab ES&H Section

4.4.1 The experimenters will require assistance with safety reviews.

V. SUMMARY OF COSTS

Source of Funds [$K]	**Equipment**	**Operating**	**Personnel** (person-weeks)
Accelerator Division	$0K	$0K	1
Particle Physics Division	$11.0K	0	11
Computing Division	$0K	0	0
Totals Fermilab	$11.0K	0	12

VI. SPECIAL CONSIDERATIONS

6.1 The responsibilities of the spokesman of the COUPP upgrade group and the procedures to be followed by experimenters are found in the Fermilab publication "Procedures for Experimenters" (http://www.fnal.gov/directorate/documents/index.html).. The Physicist in charge agrees to those responsibilities and to follow the described procedures.

6.2 To carry out the experiment a number of Environmental, Safety and Health (ES&H) reviews are necessary. This includes creating a Partial Operational Readiness Clearance document in conjunction with the standing Particle Physics Division committee. The spokesman of the COUPP upgrade group will follow those procedures in a timely manner, as well as any other requirements put forth by the division's safety officer.

6.3 All regulations concerning radioactive sources will be followed. No radioactive sources will be carried onto the site or moved without the approval of the Fermilab ES&H section.

6.4 All items in the Fermilab Policy on Computing will be followed by the experimenters. (http://computing.fnal.gov/cd/policy/cpolicy.pdf).

6.5 The spokesman of the COUPP upgrade group will undertake to ensure that no PREP or computing equipment be transferred from the experiment to another use except with the approval of and through the mechanism provided by the Computing Division management. The spokesman will also undertake to ensure that no modifications of PREP equipment take place without the knowledge and consent of the Computing Division management.

6.7 The COUPP upgrade group will be responsible for maintaining and repairing both the electronics and the computing hardware supplied by them for the experiment. Any items for which the experiment requests that Fermilab performs maintenance and repair should appear explicitly in this agreement.

6.8 At the completion of the experiment:

6.8.1 The spokesman of the COUPP upgrade group is responsible for the return of all PREP equipment, computing equipment and non-PREP data acquisition electronics. If the return is not completed after a period of one year after the end of running the spokesman of the group will be required to furnish, in writing, an explanation for any non-return.

6.8.2 The experimenters agree to remove their experimental equipment as the Laboratory requests them to. They agree to remove it expeditiously and in compliance with all ES&H requirements, including those related to transportation. All the expenses and personnel for the removal will be borne by the experimenters.

6.8.3 The experimenters will assist the Fermilab Divisions and Sections with the disposition of any articles left in the offices they occupied, including computer printout and magnetic tapes.

6.9 An experimenter will be available to report on the effort at a Fermilab All Experimenters Meeting.

SIGNATURES:

_____ / / 2008
Mike Crisler, Fermilab

_____ / / 2008
Greg Bock, Particle Physics Division

_____ / / 2008
Roger Dixon, Accelerator Division

_____ / / 2008
Victoria White, Computing Division

_____ / / 2008
William Griffing, ES&H Section

_____ / /2008
Stephen Holmes, Associate Director, Fermilab

_____ / /2008
Young Kee Kim, Deputy Director, Fermilab

APPENDIX I - Hazard Identification Checklist

Items for which there is anticipated need have been checked

Cryogenics		Electrical Equipment		Hazardous/Toxic Materials	
	Beam line magnets		Cryo/Electrical devices		List hazardous/toxic materials
	Analysis magnets		Capacitor banks		planned for use in a beam line or experimental enclosure:
	Target	**X**	high voltage (30 channels)	X	CF_3I (2-liters liquid)
	Bubble chamber		exposed equipment over 50 V		
Pressure Vessels		**Flammable Gases or Liquids**			
	inside diameter	Type:			
	operating pressure	Flow rate:			
	window material	Capacity:			
	window thickness	**Radioactive Sources**			
Vacuum Vessels			permanent installation	**Target Materials**	
	inside diameter		temporary use		Beryllium (Be)
	operating pressure	Type:			Lithium (Li)
	window material	Strength:			Mercury (Hg)
	window thickness	**Hazardous Chemicals**			Lead (Pb)
Lasers			Cyanide plating materials		Tungsten (W)
	Permanent installation	X	Scintillation Oil (1500 gal)		Uranium (U)
	Temporary installation		PCBs		Other : **Iron (Fe), Ta Cu**
	Calibration		Methane	**Mechanical Structures**	
	Alignment		TMAE		Lifting devices
type:			TEA		Motion controllers
Wattage:			photographic developers	X	scaffolding/elevated platforms
class:			Other: Activated Water?		Others